Timmins
Air Quality Study 2003

August, 2004

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Air Monitoring Section
Environmental Monitoring and Reporting Branch
Ontario Ministry of the Environment

August, 2004

PIBs 4500e

TIMMINS AIR QUALITY STUDY 2003

Executive Summary

From July 9 to August 18, 2003, the Ministry of the Environment measured hourly pollutant concentrations in Timmins using their state-of-the-art Mobile Air Quality Index (AQI) Unit. Concentrations of pollutants measured by the Mobile AQI Unit were compared with those measured at fixed monitoring sites located in North Bay, Sault Ste. Marie and Sudbury. The pollutants measured in this study were: ozone (O_3), fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). The purpose of the study was to assess the potential impact of smog produced in Ontario and the United States on the Timmins area.

For the study period, the key findings were:

- The Ontario Ambient Air Quality Criteria (AAQC) for O_3, SO_2, NO_2 and the benchmark value for $PM_{2.5}$ were not exceeded in the Timmins area.
- The maximum one-hour average ozone concentration measured at Timmins was 68 ppb and this occurred on August 1, 2003. This was well below the provincial AAQC of 80 ppb.
- The maximum 24-hour average $PM_{2.5}$ concentration measured at Timmins was 16.3 $\mu g/m^3$ and was measured also on August 1, 2003. This was well below Ontario's 24-hour benchmark value of 30 $\mu g/m^3$.
- The maximum one-hour concentrations of SO_2 and NO_2 were significantly lower than their one-hour AAQCs of 250 ppb and 200 ppb respectively.
- During smog episodes in Ontario, levels of O_3 and $PM_{2.5}$ can become elevated simultaneously but are likely to be significantly lower in Timmins than in areas to the south, such as North Bay and Sudbury.

Introduction

From July 9th to August 18th, 2003, the Mobile Air Quality Index (AQI) Unit of the Air Monitoring Section, Environmental Monitoring and Reporting Branch of the Ontario Ministry of the Environment monitored hourly concentrations of smog-related pollutants in the Timmins area in order to assess ambient air quality. The sites that were monitored are displayed in Figure 1, and the periods of measurement are as follows; South Porcupine (July 9 through July 22), Downtown Timmins (July 22 through July 29), and Baker Lake (July 29 through August 18).

The sites were monitored using the state-of-the-art Mobile AQI Unit, which is equipped with analyzers used to measure the same criteria air pollutants currently being measured across the rest of the Ministry's Ambient AQI Monitoring Network. At each location, the following pollutants were monitored: ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2). Meteorological parameters such as temperature, wind speed and wind direction were also monitored by the Mobile AQI Unit. Meteorological data recorded at the Timmins Airport were also used in the study.

The purpose of this study was to ascertain if elevated concentrations of smog pollutants are transported into the Timmins area during the summer and especially during smog episodes that are known to affect areas south of Timmins such as Sudbury and North Bay. The study was initiated in part upon the request of the Medical Officer of Health for the Porcupine Health Unit.

Concentrations of ozone, fine particulate matter, nitrogen dioxide and sulphur dioxide measured in the Timmins area by the Mobile AQI Unit were compared with those monitored at fixed locations in Sudbury, Sault Ste. Marie and North Bay (Figure 2) which are areas impacted by long-range transport of pollutants on occasion.

Though the study period ran from July 9 through August 18, ten of those days were allocated for measurements around local industries and those data were not used in this study. The remaining 31 days which make up the study period are as follows: July 9-28, 30-31, August 1-3, 7, 11-12, and 16-18.

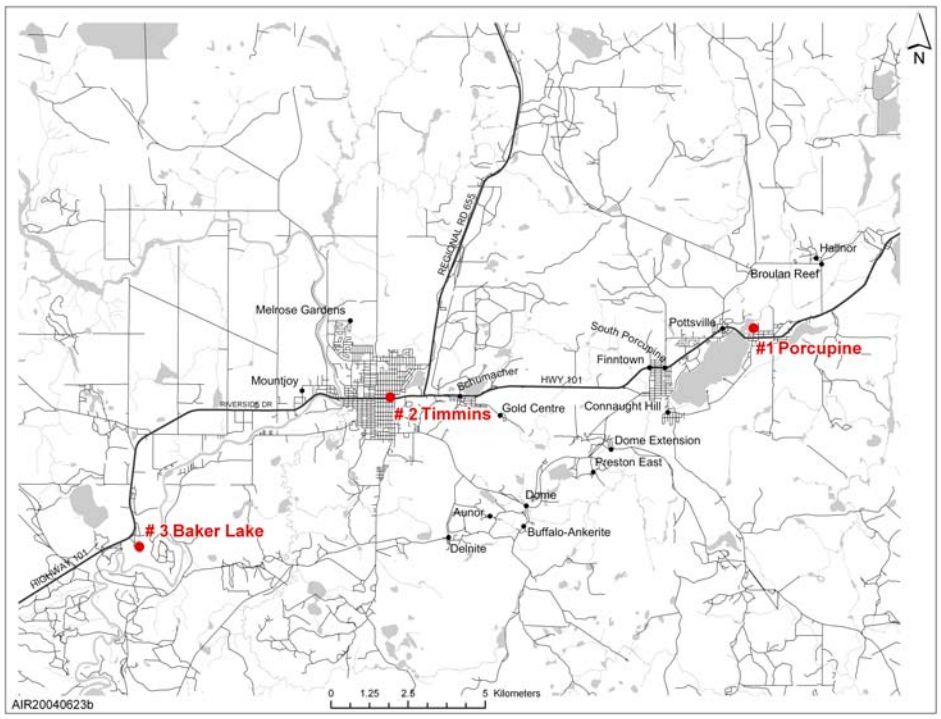

Figure 1: Mobile AQI Unit Locations for Timmins Study, 2003

Figure 2: The City of Timmins in Relation to the Fixed Air Monitoring Stations Used for Comparison in Study Area

Weather

The majority of days during the study were cloudy with a number of days recording at least a trace of rain. During the days included in the study period, daily maximum temperatures ranged from 15.1 °C to 28.6 °C. On 19 of the 31 days that measurements were taken, prevailing winds had a northerly component. The wind rose in Figure 3 summarizes the distribution of wind speeds and wind directions experienced during the study period. The wind rose illustrates that the majority of winds experienced during the study period were from the northwest and north, with a lesser amount coming from the southeast and southwest.

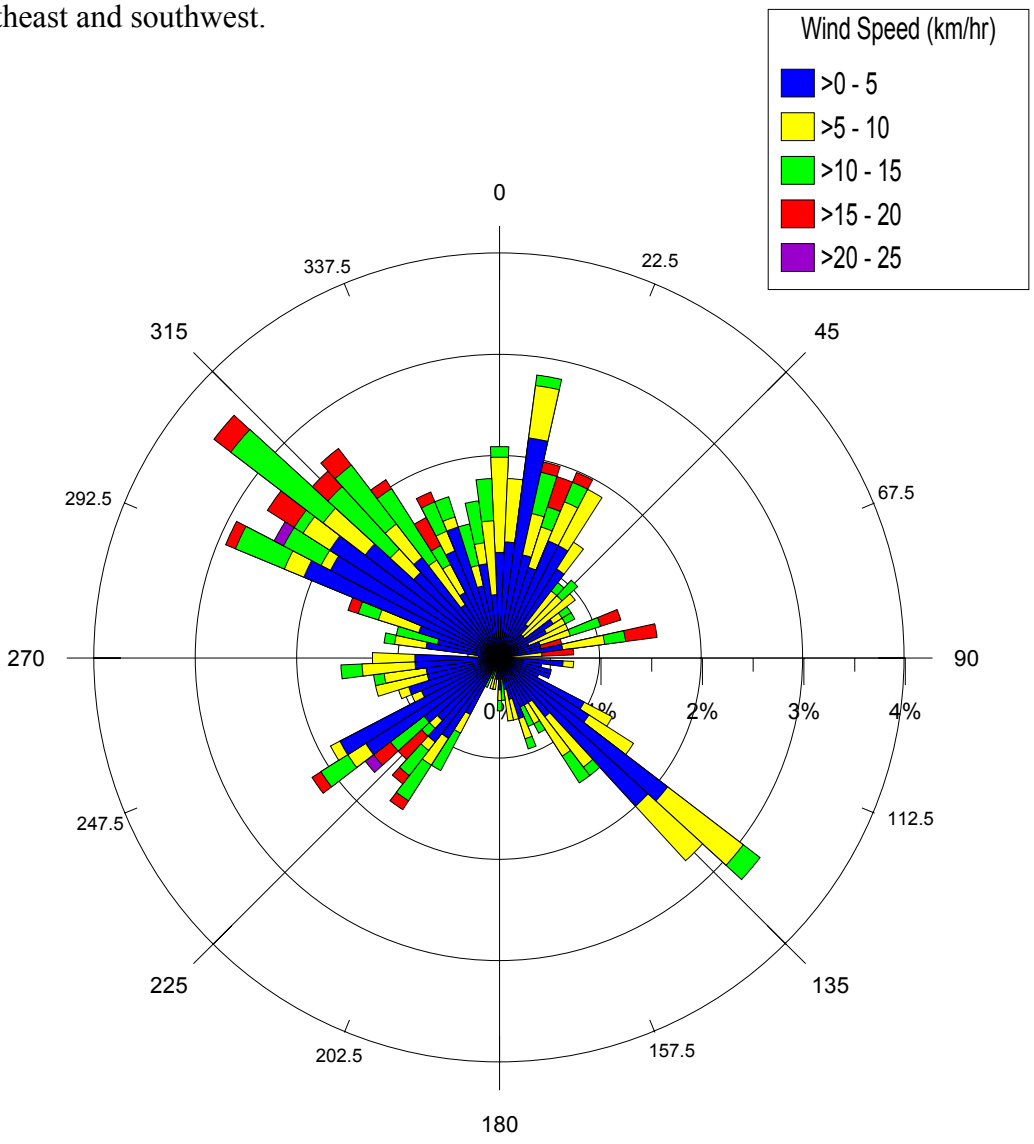

Figure 3: Wind Rose Showing Prevailing Wind Directions and Speeds in Timmins Area During 2003 Study Period

Analysis of the Data

Correlation analyses are used to detect existing relationships between multiple data sets. If the results of analyses performed on data collected by the Mobile AQI Unit in Timmins and those collected by surrounding fixed monitoring stations display an accepted level of agreement, it can be determined whether or not Timmins is impacted by long-range transport patterns similar to those found elsewhere in the province.

Useful indicators when attempting to identify the influence of an air mass as it is transported over long distances include parameters such as the daily maximum one-hour ozone concentration and the daily average 24-hour $PM_{2.5}$ concentration. These values are examined in this study, in combination with air trajectories to indicate the point of origin of an air parcel and the direction of air flow. Additionally, the statistical distribution of data obtained for other pollutants measured are compared to those obtained from the surrounding fixed monitoring stations.

Pollutants

I. Ozone (O_3)

High levels of ozone, those in excess of 80 ppb, were not observed in the Timmins area during the study period. The daily one-hour maximum ozone concentrations observed in Timmins for the duration of the study period are displayed in Figure 4. It is evident that on the majority of days monitored, levels remained well below Ontario's one-hour ambient air quality criterion (AAQC) of 80 ppb.

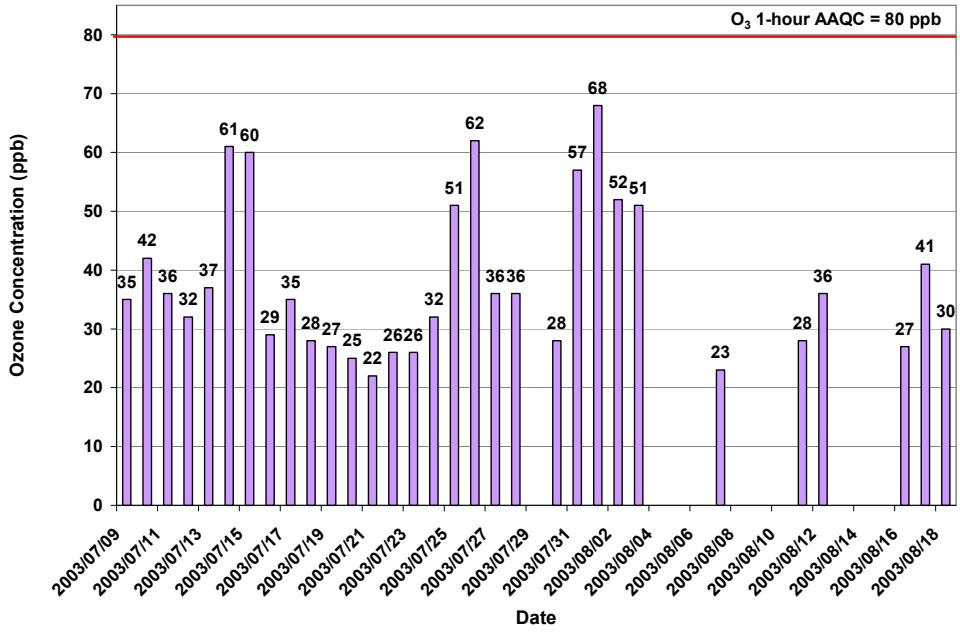

Figure 4: Daily One-Hour Maximum Ozone Concentrations in Timmins During 2003 Study Period

Of the sites included in this study, only Sudbury exceeded the one-hour criterion for ozone. This exceedance was recorded on August 1 with a value of 83 ppb. The highest one-hour ozone concentration in Timmins was also recorded on August 1 with a value of 68 ppb.

The daily maximum ozone concentrations at Timmins are compared with those found in North Bay and Sudbury. To facilitate the comparison of data collected, the study period is divided into two periods in Figures 5 and 6. Timmins is observed to experience consistently lower ozone concentrations than the surrounding fixed monitoring sites.

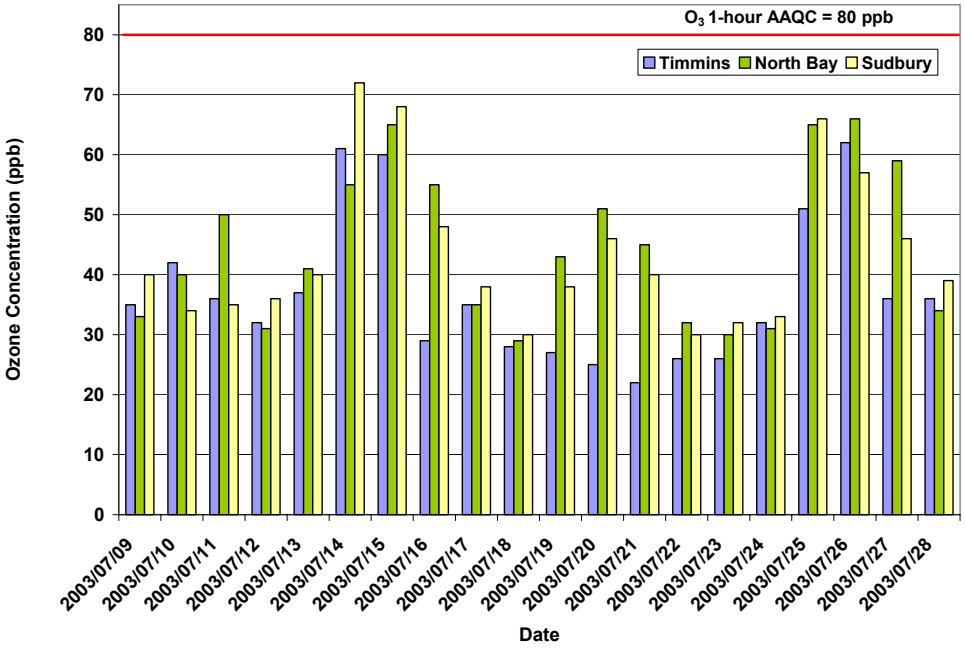

Figure 5: Daily Maximum One-Hour Average Ozone Concentrations at Timmins, North Bay and Sudbury, July 9-28, 2003

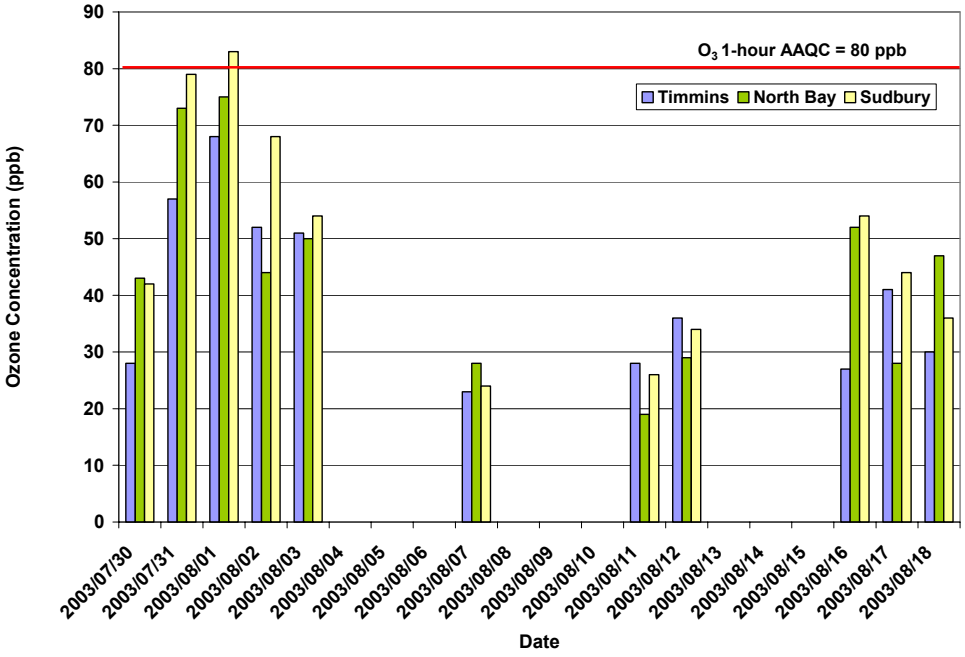

Figure 6: Daily Maximum One-Hour Average Ozone Concentrations at Timmins, North Bay and Sudbury, July 30-August 18, 2003

Two smog advisories were issued in other parts of the province during the study period. The advisories did not include the regions of Sudbury-Nickel Belt or North Bay-Nipissing, and hence, were not expected to affect the Timmins area. The dates

of the advisories were July 25-26, and July 31-August 1. During the first of these two advisories, Timmins experienced increased levels of ozone building up during the overnight period. Such temporal trends are indicative of long-range transport, since ozone cannot be formed in the absence of sunlight. Under favourable meteorological conditions which are conducive to ozone production in the rest of the province, combined with regional transport, Timmins can be impacted by an air mass traveling from southern Ontario. However, it was observed that ozone concentrations in Timmins remained in the AQI categories of good and moderate air quality and furthermore, Timmins was not as significantly impacted by ozone as were Sudbury and North Bay.

The hourly progression of the one-hour ozone concentrations from mid-day July 25 to mid-day July 26 is depicted in Figure 7. Both Timmins and North Bay recorded their peak ozone values after midnight and in the early morning hours. Although elevated values were observed at both sites, those found at North Bay were consistently higher than those found at Timmins. Similarly, high night-time values were observed overnight at Timmins and North Bay on July 31 to August 1, the period for which the second smog advisory was in effect in parts of the rest of the province. Figure 8 reveals the southwesterly air flow transported pollutants into northern Ontario from Michigan and parts of Ontario's extreme southwest on August 1, 2003. On this day, Timmins experienced its highest recorded one-hour maximum ozone concentration during the study period, as did Sudbury which exceeded the provincial AAQC.

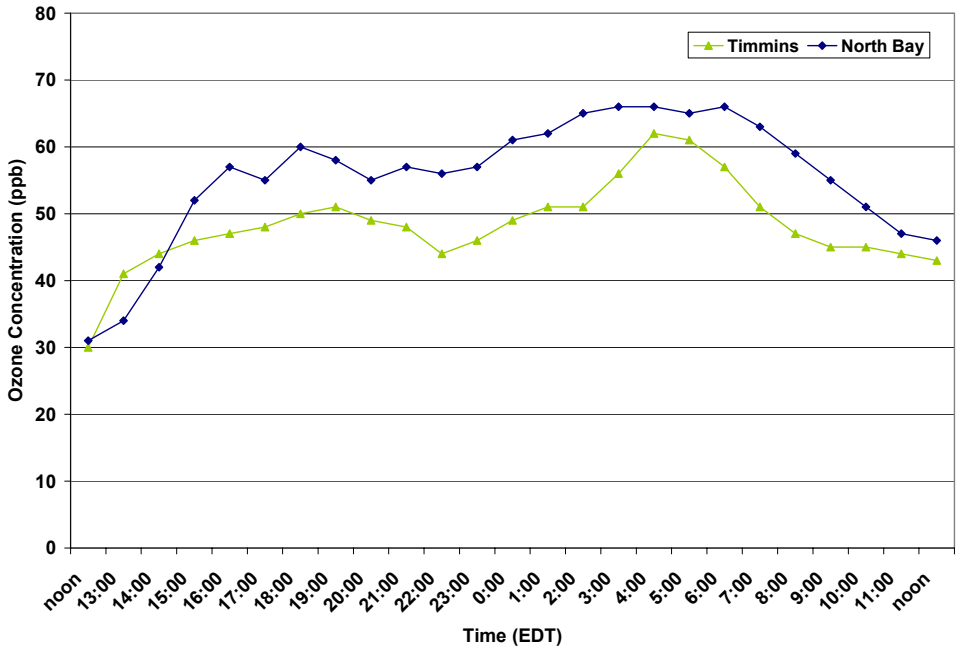

Figure 7: One-Hour Average Ozone Concentrations in Timmins and North Bay from Mid-Day July 25 to Mid-Day July 26, 2003

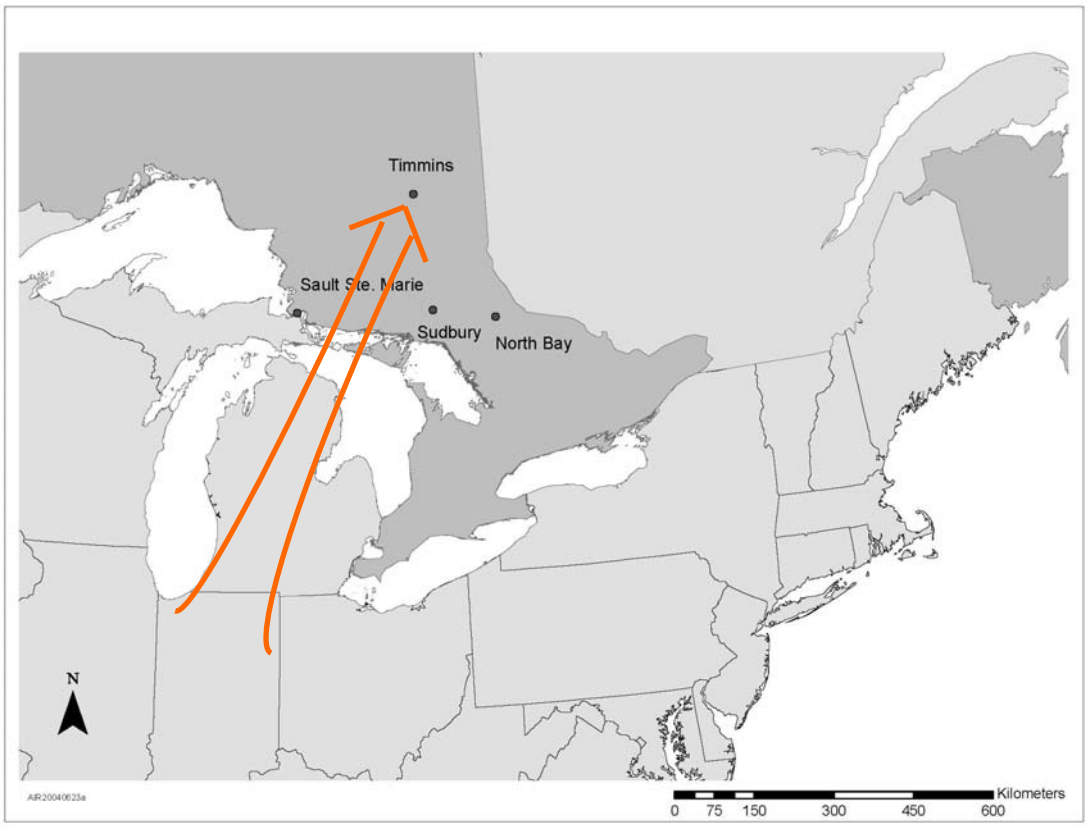

Figure 8: Air Trajectory Into Timmins on August 1, 2003

As seen in the comparison between Timmins and Sudbury in Figure 9, there exists a fair correlation between the ambient ozone measurements from the two sites. The linear correlation between the daily maximum ozone values recorded during the study period also illustrate that Timmins consistently experiences lower concentrations than does Sudbury. The slope of the regression line was 0.7, indicating that on average, the maximum one-hour ozone concentrations in Timmins are approximately 70 per cent of the maximum values recorded at Sudbury. There was a high linear correlation coefficient of 0.84.

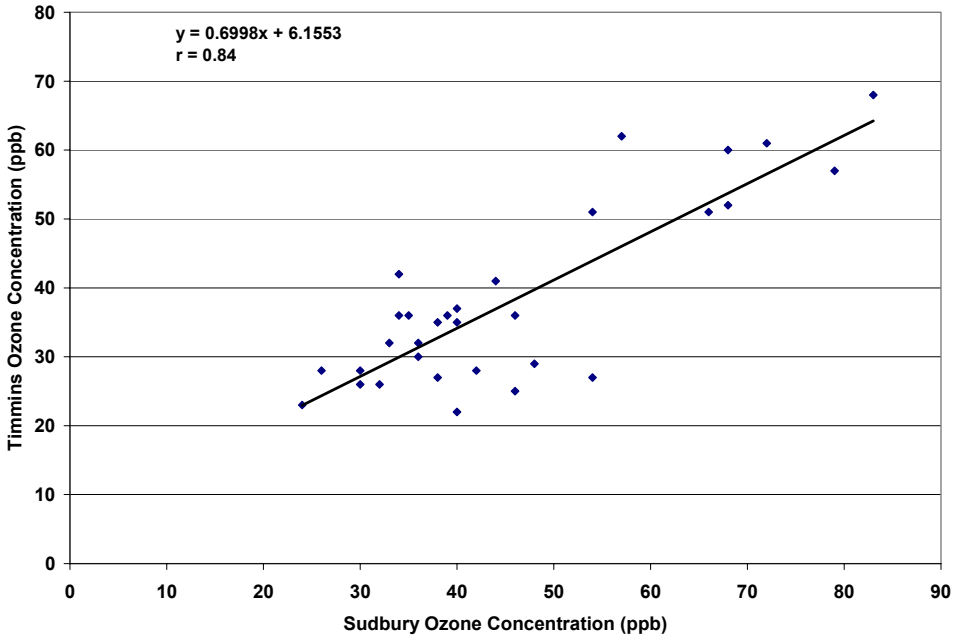

Figure 9: Linear Relationship Between Timmins and Sudbury Daily Maximum One-Hour Ozone Concentration

Overall, air quality due to ozone in the Timmins area remained in the 'very good' and 'good' categories 95.2 per cent of the time. 'Moderate' air quality was only observed for 4.8 per cent of the data recorded during the study period. For comparison, Sudbury remained in the 'very good' and 'good' air quality categories for 90.6 per cent of the time, and experienced 'moderate' air quality 9.4 per cent of the time. The frequency distribution in Figure 10 below illustrates the favourable air quality Timmins experienced during the majority of the study period.

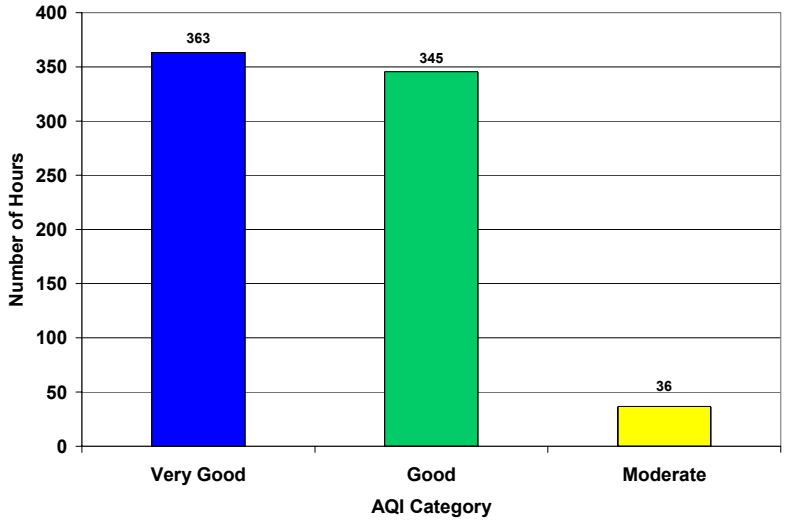

Figure 10: Frequency Distribution of Hourly AQI Readings by Category

II. Fine Particulate Matter ($PM_{2.5}$)

Timmins' $PM_{2.5}$ data were compared with data measured at North Bay and Sault Ste. Marie. The fixed monitoring station in Sudbury was not equipped with a $PM_{2.5}$ monitor during the study period. Figures 11 and 12 illustrate the measured 24-hour average $PM_{2.5}$ concentrations at Timmins, North Bay and Sault Ste. Marie throughout the study period. On average, North Bay recorded higher 24-hour averages values of $PM_{2.5}$ than did Timmins. Additionally, Sault Ste. Marie recorded significantly higher concentrations of $PM_{2.5}$. The highest 24-hour $PM_{2.5}$ concentration recorded at North Bay was 20.1 $\mu g/m^3$ on July 15 whereas the highest 24-hour average $PM_{2.5}$ concentration recorded at Sault Ste. Marie was 30.1 $\mu g/m^3$ on July 25, exceeding the benchmark value. The corresponding value in Timmins was recorded as 16.3 $\mu g/m^3$ on August 1. The highest one-hour $PM_{2.5}$ concentration recorded at Timmins was 33 $\mu g/m^3$ and the corresponding value in North Bay was 37 $\mu g/m^3$. Both of these values were recorded on August 1. These observations coincide with the maximum one-hour ozone concentration, also recorded on August 1.

Overall, the 24-hour concentration values of $PM_{2.5}$ in Timmins remained far below Ontario's benchmark value of 30 $\mu g/m^3$ throughout the study period, and significantly lower than the $PM_{2.5}$ readings measured in North Bay and Sault Ste. Marie.

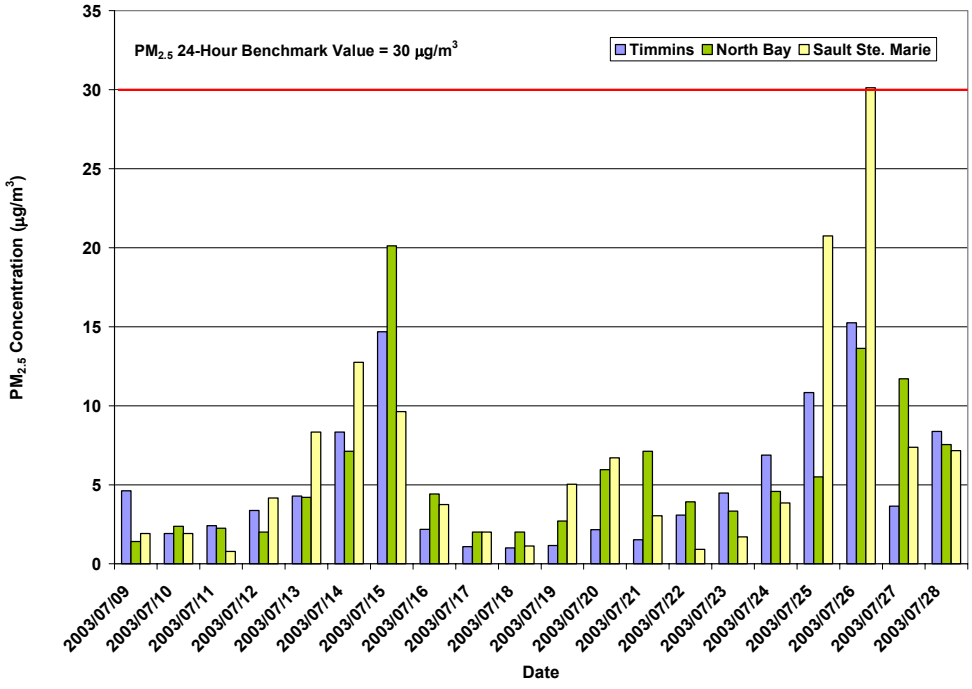

Figure 11: 24-Hour Average $PM_{2.5}$ Concentrations at Timmins, North Bay and Sault Ste. Marie, July 9-28, 2003

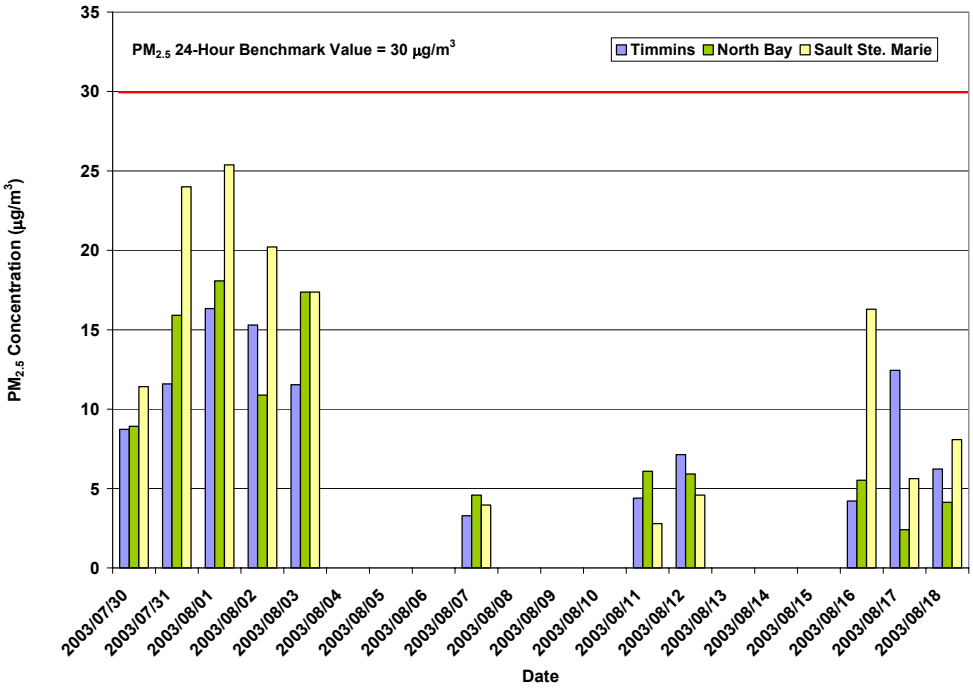

Figure 12: 24-Hour Average $PM_{2.5}$ Concentrations at Timmins, North Bay and Sault Ste. Marie, July 30-August 18, 2003

The comparison between Timmins and North Bay in Figure 13 illustrates that $PM_{2.5}$ measurements in Timmins were consistently lower than those found in North Bay. The slope of the linear correlation reveals that the 24-hour average concentrations in Timmins are approximately 70 per cent of the $PM_{2.5}$ concentrations found in North Bay. The correlation coefficient of 0.74 indicates greater variability than was found in the comparison of the ozone data.

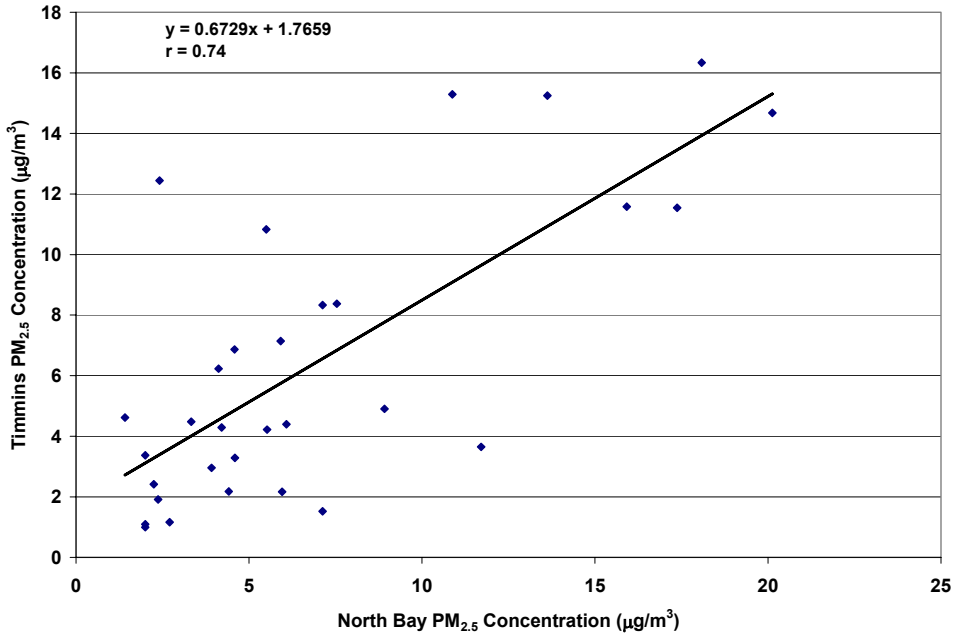

Figure 13: Linear Relationship Between Timmins and North Bay 24-Hour Average $PM_{2.5}$ Concentrations

A comparison of the percentile distributions of the 24-hour averages of $PM_{2.5}$ for Timmins, North Bay and Sault Ste. Marie using box plots in Figure 14 reveals that concentrations measured at Timmins were lower than those at North Bay and significantly lower than those of Sault Ste. Marie.

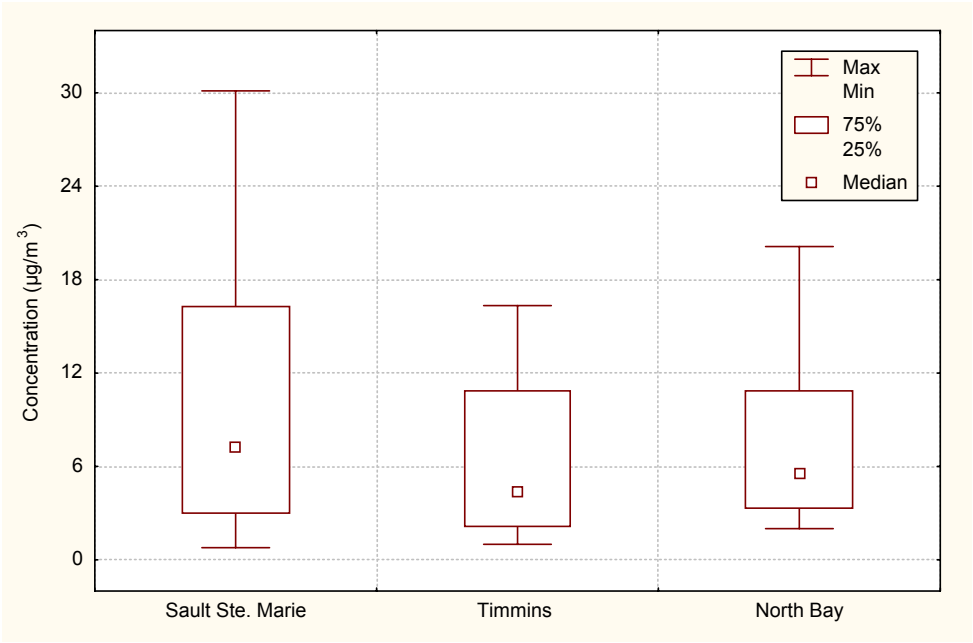

Figure 14: Box-Plot Summary Statistics of 24-Hour Average $PM_{2.5}$ Concentrations at Sault Ste. Marie, Timmins and North Bay

III. Sulphur Dioxide (SO_2)

The highest one-hour average SO_2 concentration recorded at Timmins during the study period was 15 ppb, while at Sudbury the highest one-hour concentration was 70 ppb. Both of the maximum one-hour concentrations were well below the provincial one-hour SO_2 AAQC of 250 ppb.

IV. Nitrogen Dioxide (NO_2)

Nitrogen dioxide observations in the Timmins area were compared to those found in North Bay and Sault Ste. Marie. The one-hour average concentration of NO_2 in Timmins reached a maximum of 18 ppb on July 24. This value is significantly lower than the one-hour AAQC of 200 ppb set by the Ministry for NO_2. The highest 24-hour average concentration was also recorded on July 24 and had a value of 5.2 ppb, which is also considerably lower than the 24-hour NO_2 AAQC of 100 ppb.

The comparison of the daily one-hour maximum NO_2 concentrations for the duration of the study period is illustrated in Figures 15 and 16. Data from Timmins are compared with observations from North Bay, Sault Ste. Marie and Sudbury, the other northern region stations currently monitoring NO_2. The final three days of the study period do not contain valid data for NO_2 in Timmins and were not included.

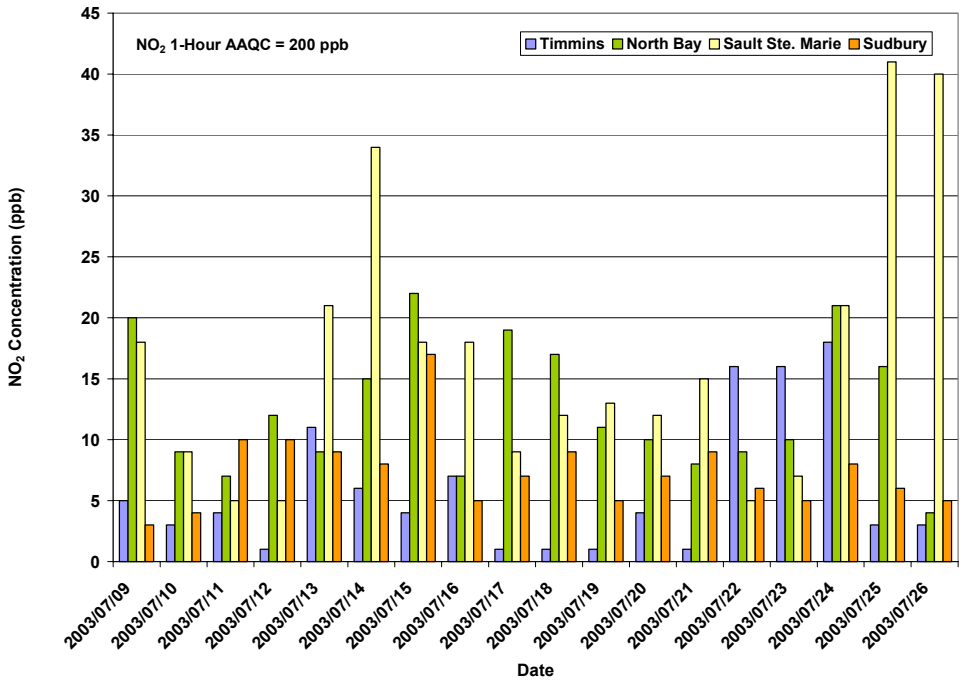

Figure 15: Daily Maximum One-Hour Average NO_2 Concentrations at Timmins, North Bay, Sault Ste. Marie and Sudbury, July 9-26, 2003

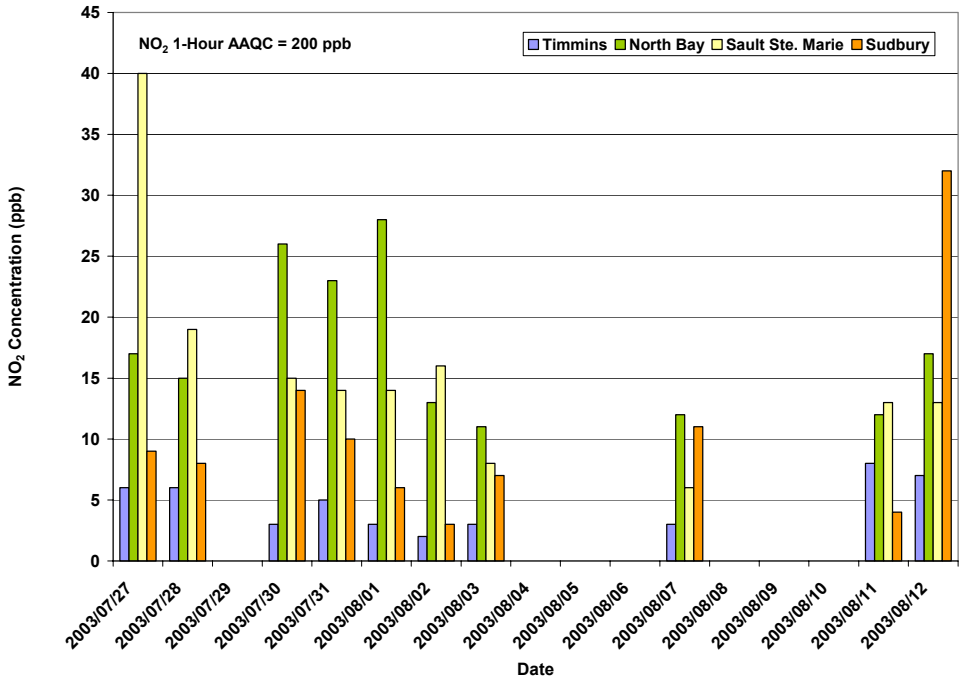

Figure 16: Daily Maximum One-Hour Average NO_2 Concentrations at Timmins, North Bay, Sault Ste. Marie and Sudbury, July 27-August 12, 2003

A comparison of the percentiles of NO_2 observed at Timmins, North Bay, Sault Ste. Marie and Sudbury shows that levels at Timmins were the lowest of all the stations observed during the study period. This is shown by the data presented in Figure 17.

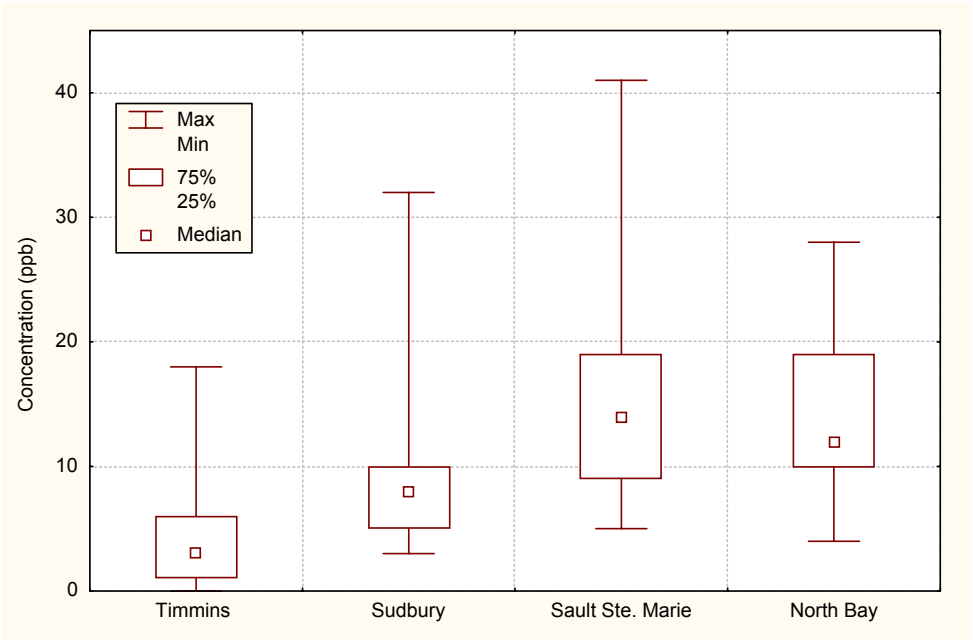

Figure 17: Summary Statistics for Daily Maximum NO_2 Concentrations at Timmins, North Bay, Sault Ste. Marie and Sudbury

Conclusion

During the period of study, none of the pollutants measured by the Mobile AQI Unit in the Timmins study area exceeded their AAQC. It was observed on several occasions that ozone concentrations reached their peak values overnight which indicated transport into the Timmins area. However, the maximum concentrations did not reach or exceed the provincial AAQC of 80 ppb. On August 1, 2003 when a smog advisory was called for southern Ontario and a southwesterly flow developed over northeastern Ontario, the ozone monitor at Sudbury recorded a one-hour average of 83 ppb, the only exceedance of the AAQC during the study period, and the Mobile AQI Unit located in the Timmins area recorded a corresponding value of 68 ppb. On the same day, the Mobile AQI Unit recorded a $PM_{2.5}$ 24-hour average of 16.3 $\mu g/m^3$, its highest throughout the study period, which was significantly lower than the 30 $\mu g/m^3$ benchmark value.

The linear correlation studies of the maximum one-hour ozone concentrations and the 24-hour average $PM_{2.5}$ concentrations recorded at Timmins and surrounding sites showed a very good association. On average, it was found that maximum values at Timmins were 70 per cent of the corresponding values at Sudbury in the case of ozone, and 70 per cent of the corresponding values at North Bay in the case of $PM_{2.5}$.

Comparison of the maximum one-hour NO_2 concentrations at Timmins with corresponding values at North Bay, Sault Ste. Marie and Sudbury showed that the Timmins concentrations were considerably lower than those recorded at the fixed monitoring sites in the other northern cities.

Overall, the generally wet and cool conditions experienced during the study period were not conducive to the production of high smog-related pollutant levels in the Timmins area. On occasions that elevated pollutant concentrations were transported into the area, specifically those of ozone, Timmins still did not reach the Ontario AAQC of 80 ppb. These results suggest that during smog episodes in Ontario, the concentrations of ozone and fine particulate matter in Timmins are likely to be significantly lower than in areas of southern Ontario.